SRS-4104 Science Hightlights - Mercury as a Global Pollutant - Ralph DiCosty

Mercury pollution has been in the national news lately as another sideeffect of industrialization. In particular, mercury is emitted from coalburning power plants, although this is not the only source of mercury in the environment. When the metal is deposited in aquatic systems, it can be easily transformed into methylmercury, a very toxic form. The federal government (EPA) is requiring a 70% reduction nationwide in the amount of mercury emitted from power plants but some states, such as Michigan, have set the tougher standard of 90% reduction by 2015. Mercury is a trace element in coal, forming roughly 1 part per billion of the gas caused by incineration. Attendance at the Eighth International Conference on Mercury as a Global Pollutant held on August 6-11 in Madison, Wisconsin, is one indication of the attention being given to mercury by the scientific community. The conference drew over 1000 participants from 68 nations, and featured an update on the status of four key mercury issues: (1) Source Attribution of Atmospheric Mercury, (2) Health Risks and Toxicological Effects of Methylmercury, (3) Recovery of Mercury Contaminated Fisheries, and (4) Societal Consequences of Mercury Pollution.

The conference featured an innovative process for developing a synthesis of science understanding of an important issue. Each morning, a paper on one of the four key issues was presented by an expert panel before all conference participants. The panels responded to questions and comments from the audience, with discussions continuing on bulletin boards throughout the week. Before the conclusion of the conference, each conferee had the opportunity to vote for or against a series of declarations offered by each panel. The conference declaration was endorsed in full by the 37 scientists comprising the expert panels, and was ratified by a large majority of the conferees. According to a conference news release, "Mercury pollution can threaten the health of people, fish, and wildlife everywhere, from industrial sites to remote corners of the planet, but reducing mercury use and emissions would lessen those threats."

Points in the declaration on mercury include:

- •On average, mercury fallout from the atmosphere has tripled since the Industrial Revolution 200 years ago. Although mercury emissions from developed countries have decreased for the last 30 years, these decreases have been offset by a rise in mercury emissions from developing countries.
- •Methylmercury, a form of mercury in which mercury is chemically bound to carbon, is toxic to the developing fetus. Recent evidence also implicates this form of mercury as a contributing factor to cardiovascular disease, especially in adult men. There is no evidence that selenium in the human diet protects against methylmercury's ill effects.
- •Methylmercury in fisheries is expected to decline with reduced mercury inputs, but the timing of the decline varies from years to centuries, according to ecosystem characteristics.
- •Human-caused mercury pollution has had and continues to have documented adverse socioeconomic effects.

Conference videos, a speech by Senator Russ Feingold, an article about Clancy The Mercury-Detecting Dog, and other information are available at www.mercury2006.org. The full declaration is available at: http://www.mercury2006.org/portals/31/press/pressconference/mercury2006MG081106.pdf. The papers presented by the expert panels will be submitted for publication in the Swedish journal Ambio. The Ninth International Conference on Mercury as a Global Pollutant will be held in Guiyang, China in June 2009.

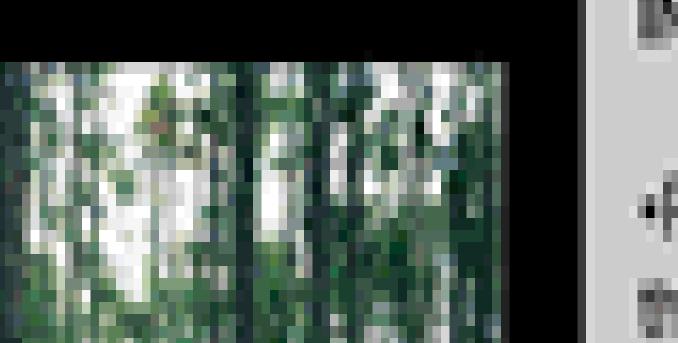
A similar approach to developing a science synthesis will be attempted at the National Conference on Ecosystem Restoration (see Upcoming Events), which will feature Restoration Coffeehouses (RCH). These RCH sessions will serve as an open forum for attendees to discuss lessons learned, help identify improved pathways based on existing successes and failures and explore vital issues faced by restoration practitioners. These sessions will also incorporate interactive discussion amongst panel members and conference participants, with major conclusions synthesized in real-time by panel leaders. Following NCER, conclusions of these RCH sessions will be converted into a "restoration strategies" white paper.

Impact of Prescribed Fire on Mercury Cycling in Southeastern US Forests

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Unburned plot



Plot burned annually.



Plot burned every 4 years...

INTRODUCTION

 Prescribed forest fires affect 1-2 million hectares per year in the Southeastern US (1,2) (Figure 1). Prescribed fire reduces wildfire risk, prepares sites for seeding/planting, and is an important tool for restoring fire-dependent ecosystems (3).

The Southeastern US receives relatively high inputs of mercury (Hg) (wet deposition of 12-30 µg/m2 = 0.12-0.30 g/ha) compared to the rest of the US (4).
 Thus, prescribed forest fire in the Southeast US is a potentially significant but unknown source of (re-emitted) Hg

-RESEARCH QUESTIONS

to the atmosphere.

- How much Hg is emitted from prescribed fires in the southeastern US?
- Is the emitted Hg a "re-emission" of previous atmospheric deposition?
- Can forests with well-documented fire history be used to estimate net atmospheric Hg deposition?

 What is the vertical distribution of Hg in a Spodosol (Podzol) soil of Florida, USA?

MATERIALS AND METHODS

Study Site: Osceola National Forest, Florida (Figure 1).

Treatments (since 1958): (1) Unburned, (2) Burned Every 4 Years, (3) Burned Annually.

 Soil and Vegetation: Acid sandy Spodosol (Podzol) (Figure 2), longleaf pine (Pinus palustris Mill.)

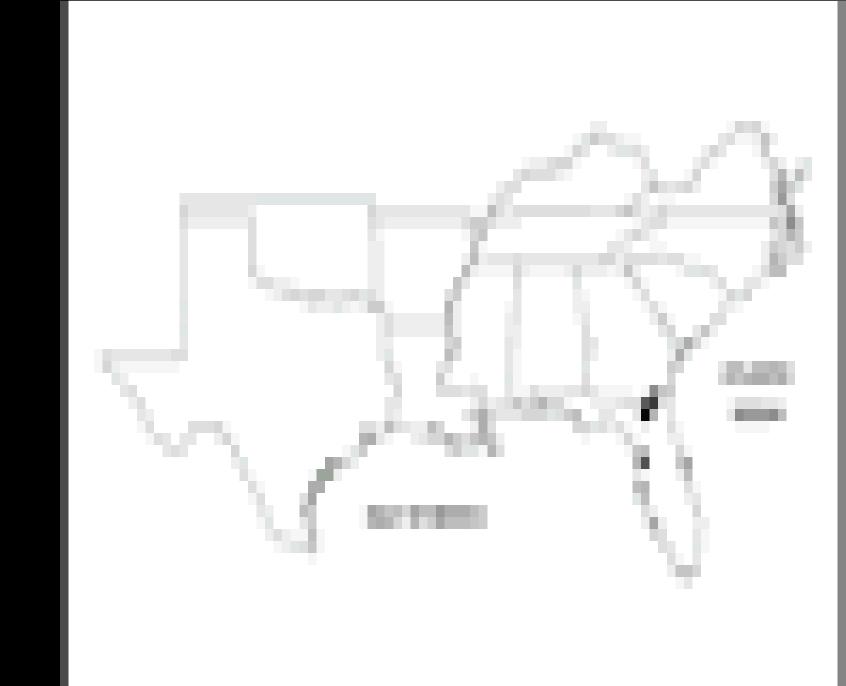


Figure 1. Mercury wet deposition in 2003 in the Eastern United States. Figure 1. Map of Southeastern US, Showing Study Site (a) and Nearby Monitoring Stations (*)

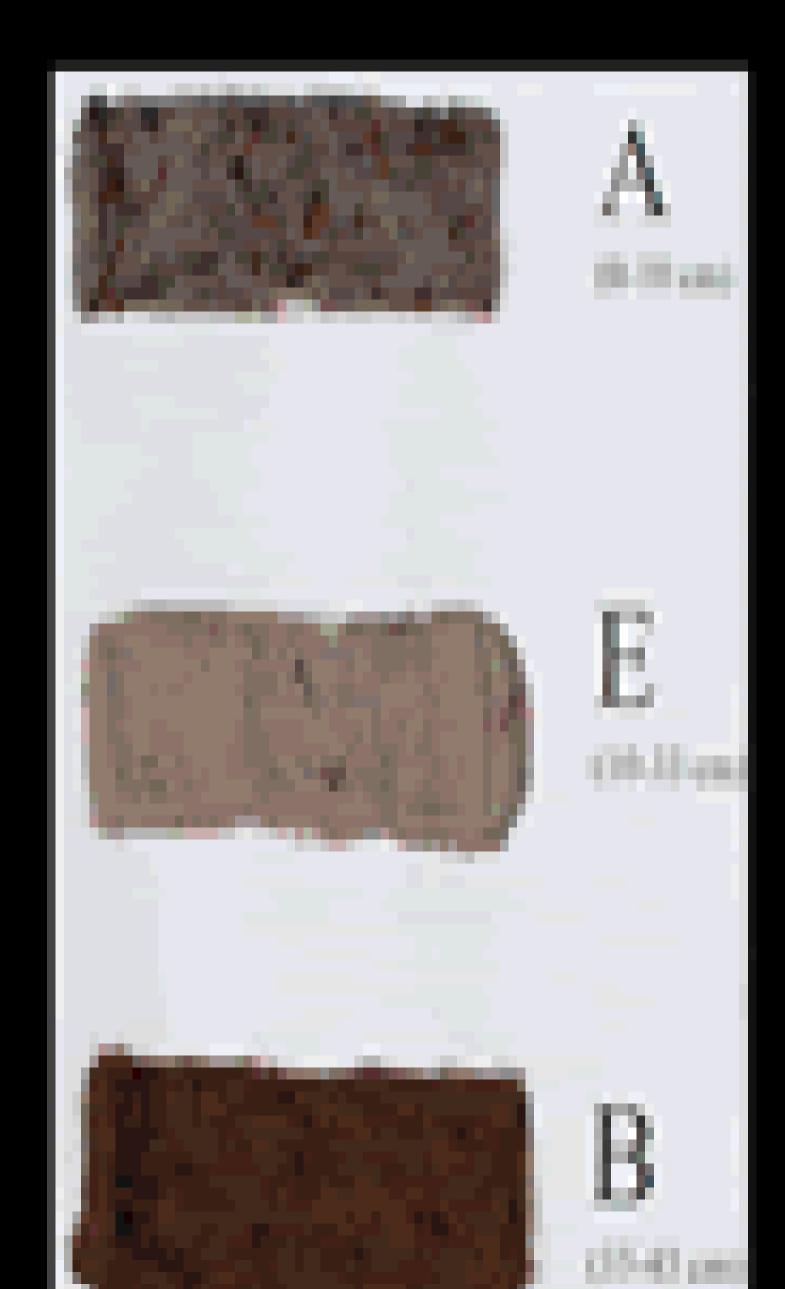


Figure 2. Mineral soil horizons of the Osceola National Forest (Soil Type: sandy, siliceous, thermic Ultic Alaquod)

- Soil Hg: Microwave digestion (modified US EPA Method 3051) followed by ICP-MS.
- •Soil Carbon and Nitrogen: Automated dry combustion.
 •Independent Estimate of Wet + Dry Mercury Deposition to the Study Site = 17.1 µg m⁻² yr⁻¹ (0.171 g ha⁻¹ yr⁻¹). Wet deposition based on two nearest sites of the Mercury Deposition Network (Figure 1) (see Ref. 4), dry deposition based on map of Seigneur et al. (5).

MERCURY IN THE SOIL PROFILE

Fire generally decreased Hg in the forest floor (O horizon) (Figures 3A and 3B).

MORE INFORMATION

See DiCosty, R.J.,
Callaham, M.A., Jr., &
Stanturf, J.A. 2006.
Atmospheric Deposition and
Re-Emission of Mercury
Estimated in a Prescribed
Forest-Fire Experiment in
Florida, USA, Water, Air, &
Soil Pollution, DOI:
10.1007/s11270-006-9149-3.



Figure 2. Map showing study site location (*), and monitoring stations (*, National Abmospheric Deposition Program, 2005) used for calculation of well deposition.

•Hg was significantly (and positively) correlated with C and N in the E and B horizons (R2 = 0.3 to 0.6, p < 0.1).</p>

The proof of the p

MERCURY EMISSION/DEPOSITION: DO PLOTS OF KNOWN FIRE HISTORY ALLOW US TO ESTIMATE NET HG DEPOSITION?

incentrations. Different

- If extrapolated to the area burned in the Southeastern US, our data suggest that prescribed fires in the Southeastern US emit 0.1 – 0.3 Mg Hg/yr. This is small compared to US anthropogenic emissions (144 Mg/yr) (6). However, Hg emissions elsewhere in the Southeast undoubtedly vary according to fire regime, atmospheric Hg deposition, and bedrock Hg concentrations.
- -We plan to extend our study to more burned forests in the Southeastern US to determine the influence of other variables on mercury storage and emissions. (Funding provided by Joint Fire Science Program).
- These plots, with known fire history, may provide a reasonable estimate of net atmospheric Hg deposition. Explanation is given below:
- *Emission of Hg from annually burned plots * [Hg in unburned O horizon Hg in annually burned O horizon] / 46 years = 0.180 g har yr 1. (46 years is the length of the prescribed fire experiment.)
- *Independent estimate of Hig deposition (wet + dry) from regional monitoring network/computer model = 0.171 g hart yrrt.
- -Difference between above emission and deposition estimates is merely 5%. This suggests (1) the atmosphere is the main Hg source at this site, (2) annual burning simply re-emits previous atmospheric deposition, and (3) the unburned forest floor has retained nearly all atmospherically deposited Hg for 46 yr.
- •The strong retention of Hg in the unburned O layer is supported by the lack of a significant increase in the areal Hg concentrations of the unburned A horizons relative to the burned A horizons (Figure 3A).
- Confounding processes, such as runoff, erosion, and release of geologic Hg, are likely of minor importance at this flat, heavily vegetated site that lies outside the earth's major mercuriferous zones (as mapped in Reference 7).

MAJOR CONCLUSIONS

Mercury emitted from prescribed forest fires at the Osceola National Forest, Florida is probably derived from previous atmospheric deposition.

Forested plots with known fire history may be useful for measuring the net atmospheric deposition of Hg.

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